MAY 29 1969

NATIONAL BUREAU OF STANDARDS REPORT

10 040

EXAMINATION OF ELECTROFORMED NICKEL PRINTING PLATE SAMPLES J-1, J-2, 695-B AND 695-T

To

Electrolytic Section
Bureau of Engraving and Printing

NBS

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

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By
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To
Electrolytic Section
Bureau of Engraving and Printing

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Examination of Electroformed Nickel Printing Plate Samples J-1, J-2, 695-B and 695-T

Material Submitted: Four strips representative of electroformed plate material described in Table 1 were submitted for examination of mechanical properties and microstructure. As received, the strips had a smooth as-electroformed finish on the printing face and a ground finish on the back face.

Hardness: Macrohardness measurements obtained on the strips are as follows:

Strip No.	Hardness, Rockwell 15T Printing Face	Back
J-1	87.8	87.6
J-2	87.4	87.6
695-B	89.0	87.6
695-T	87.8	87.6

Microhardness measurements were made on the cross-sectional surfaces of mounted specimens. The values obtained using a Knoop indentor, 200 gram load and 20X objective are as follows:

	Adjacent to Printing Face		Mid-Section		Adjacent to Back	
Strip No.	KHN	Approximate Rockwell B, Equivalent	KHN	Approximate Rockwell B, Equivalent	KHN	Approximate Rockwell B, Equivalent
J-1	220.0	93.8	184.4	86.0	203.0	90.5
J-2	202.0	90.2	178.9	84.2	181.3	85.3
695-B	239.5	97.8	196.8	89.0	193.3	88.3
695-T	235.2	96.8	183.2	85.7	186.0	86.5

Tensile Properties: A tensile test specimen with a nominal 0.400 inch width and 2.00 inch gage length in the reduced section was prepared from each strip. As-received thickness of the strips was maintained in the machined tensile test specimens. Tensile properties obtained are given in Table 2.

Metallographic Examination: All of the plate samples had a columnar grain structure characteristic of electroformed nickel. The columnar grains observed in J-1, J-2 and 695-T, Figures 1a, ib and 1d, respectively, are quite similar in size; while the columnar grains observed in 695-B, Figure 1c, are smaller than that in the other samples. Figure 2, at a lower magnification, shows layers of very fine columnar grains adjacent to the printing faces of the electroformed plates. The lavers in strips J-1

and J-2 have no well-defined depth and blend gradually into the coarser columnar grains that predominate in the structure. The layers, approximately 0.002 inch deep, in 695-B and 695-T, are sharply defined and appear to have resulted from some interruption or change in the electroforming process.

Discussion and Conclusions: The average tensile strengths of the "J" and "695" samples are identical and the average yield strength of the "J" samples is lower than that of the "695" samples. The yield strength and ultimate tensile strength obtained for the subject samples are lower and the percent elongation higher than that obtained in a previous test on electroformed material produced in a sulfamate bath and reported in Table 2, NBS report No. 9522.

The average Rockwell 15T macrohardness of the printing face of the "J" samples is slightly lower than that of the "695" samples; while the Rockwell 15T hardness of the back faces of all of the samples are identical. Microhardness measurements, Knoop and related Rockwell B equivalents, indicated that the hardness adjacent to the printing face and in the mid-section of the "J" material was lower than that in the "695" material.

The structures of all of the samples were free of voids. The characteristic columnar grains of electroformed nickel were observed in all of the samples. Fine columnar grains adjacent to the printing faces of the "J" samples blended gradually into the coarser columnar grains predominating in the structure of these samples. A sharply defined layer of fine columnar grains was observed adjacent to the printing faces of the "695" samples. This layer appears to have resulted from some interruption or change in the electroforming process. It could have been formed by removal of the plate from the electroforming bath, by a change in current density, bath composition or bath temperature.

Table 1. Identification of Electroformed Nickel Plate Test Strips

BE&P Identification	Thickness Inch	Bath Type	Strip Origin
J-1	0.0614	Sulfamate	It is uncertain whether J-1 and J-2 are from the same plate or from two different plates.
J-2	0.0593	Sulfamate	
695-B	0.0405	Sulfamate	Bottom of plate 695
695-T	0.0402	Sulfamate	Top of plate 695

Table 2. Tensile Properties of Electroformed Nickel Plate Material

Item	Yield Strength, 0.2% Offset	Ultimate Tensile Strength	Elongation in 2 Inches
	psi	psi	%
J-1	45,250	72,550	14.7
J-2	43,250	72,000	14.7
Average	44,250	72,275	14.7
695-B	49,850	75,550	17.3
695-T	42,800	69,000	17.0
Average	46,325	72,275	17.1
BE&P Plate Sample No. 39868B*	61,800	88,100	9.5
BE&P Plate Sample No. 39868T*	53,200	81,100	14.0
Average	57,500	84,600	11.7

* Sample examined in NBS report No. 9522

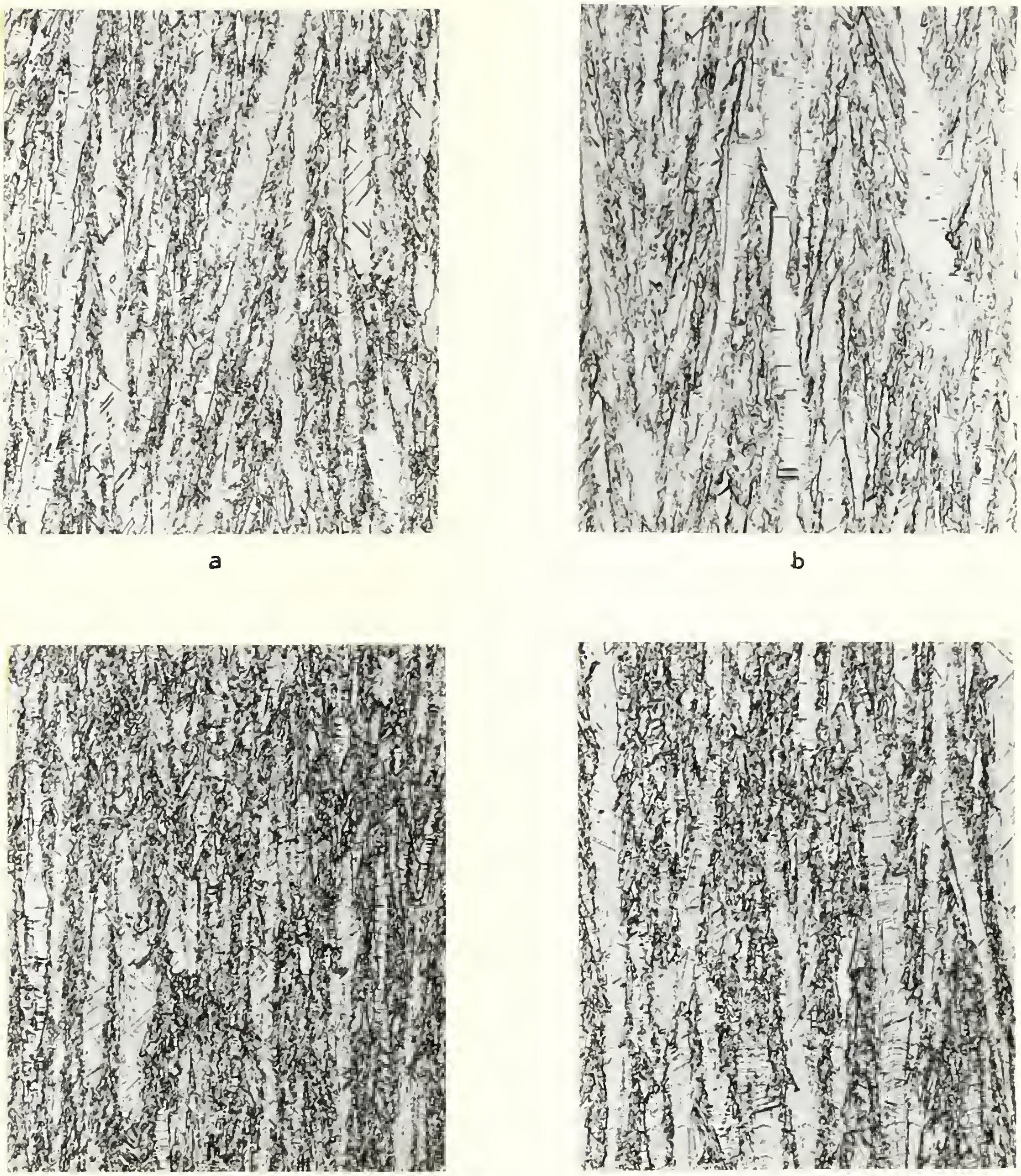

Figure 1. Microstructures in transverse sections of electroformed nickel plates. Principal axes of columnar grains are normal to plate surfaces. Etched with Carapella's reagent. X 250.

a. Plate J-1.
b. Plate J-2.
c. Plate 695-B.
d. Plate 695-T.

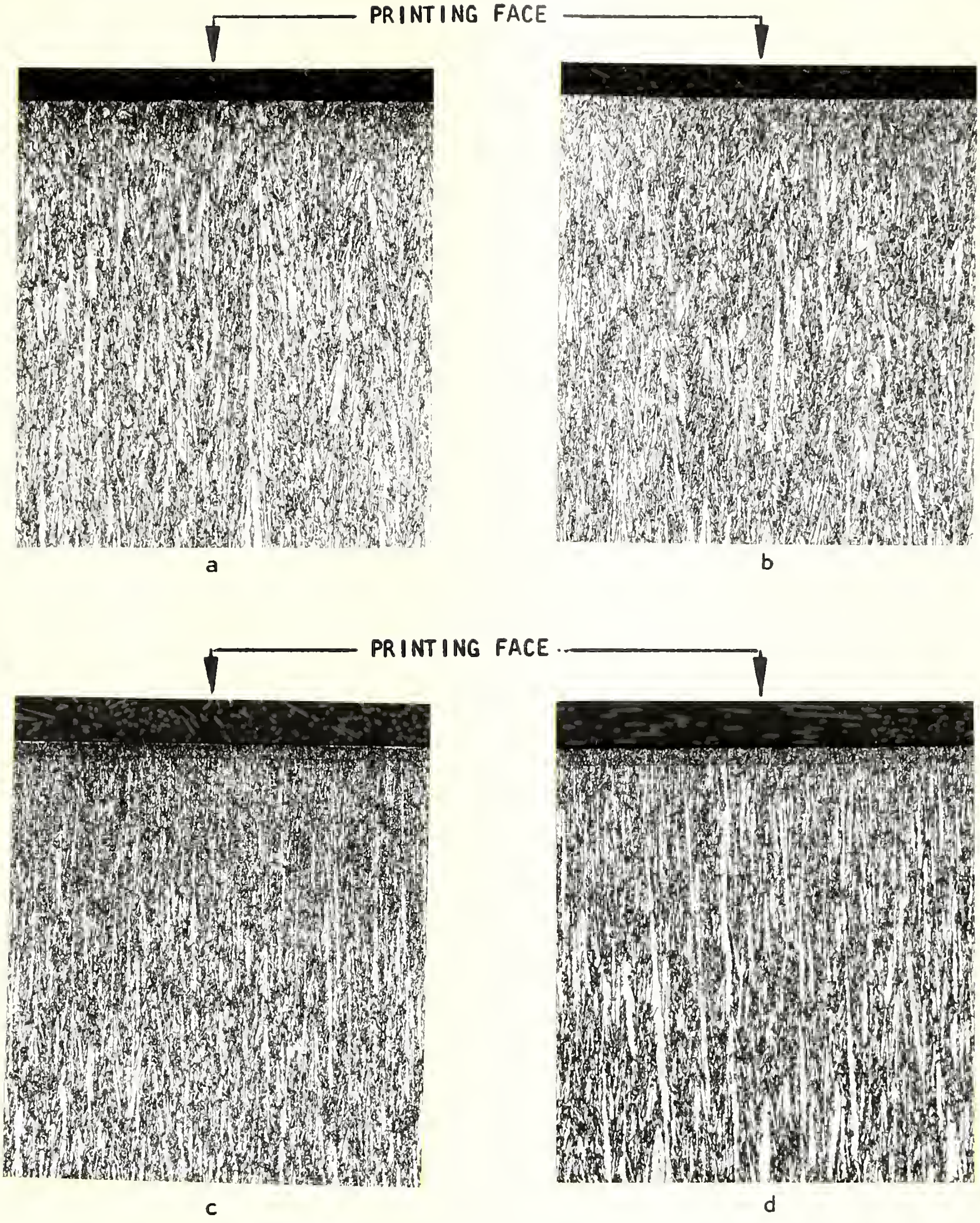

Figure 2. Microstructures adjacent to printing face of plates. Etched with Carapella's reagent. X 50.

a. Plate J-1.
b. Plate J-2.
c. Plate 695-B.
d. Plate 695-T.

Note the well defined layer of fine columnar grains approximately 0.002 inch thick adjacent to the printing face of plates 695-B and 695-T.

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